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POLLUTION IN THE LAKE TAHOE BASIN IN CALIFORNIA-NEVADA

A. W. West, et al

Federal Water Pollution Control Administration
Cincinnati, Ohio

July 1966

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REPORT ON POLLUTION IN THE LAKE TAHOE BASIN

California - Nevada

by

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in cooperation with the
Southwest Regional Office
San Francisco, California

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FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

Cincinnati, Ohio

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CONCLUSIONS AND RECOMMENDATIONS

Lake Tahoe, one of the clearest freshwater lakes in the world, is an irreplaceable scenic treasure and national resource. To protect it from destruction by man-made pollution and man-accelerated eutrophication is an urgent task of Federal, State, and local government.

Lake Tahoe is threatened by nitrogen and phosphorus pollutants from sewage discharged within the Basin. These pollutants speed up the rate of eutrophication. The phosphorus content of Lake Tahoe water has already reached a critical level. Objectionable algal growths are already present in near-shore areas where phosphorus concentrations are highest. A substantial increase in nitrogen, common in human wastes, could create obnoxious algae throughout the Lake, destroy its clarity and make it distasteful to sight and smell.

Lake Tahoe is threatened with pollution by silt erosion from lands where the natural vegetative cover is destroyed and soil is disturbed by land clearing operations. Silt, transported into the lake by runoff during the rainy season, reduces the clarity and beauty of the water and can destroy aquatic life and adversely change the composition of those organisms that may be present.

Lake Tahoe, the most important resource of the Basin, is used for public water supply, fishing, and all water sports. It now supports a large tourist economy, which is expected to multiply in value several times in the next several decades. The future economy of the region, however, is endangered by waste discharges.

Pollution of Lake Tahoe degrades a resource which, recreationally and aesthetically, belongs to the entire nation. To preserve this natural heritage for all peoples, man-associated pollution must be stopped.

To stop the deterioration of Lake Tahoe now, and to restore the quality of its water where it has already been damaged, the following general improvements should be made:

1. Establish additional public utility districts, or expand the boundaries and jurisdiction of existing districts, to include the entire populated drainage area of Lake Tahoe.

2. Extend public sewer service to collect all sewage from the Lake Tahoe drainage area.

3. Provide a minimum of secondary treatment for all wastes collected in the drainage area.

4. Export all sewage and garbage out of the Lake Tahoe Basin.

5. Minimize the transport of silt into Lake Tahoe by including effective soil conservation and erosion control practices in the clearing, development and use of lands within the Basin.

SUMMARY

The beauty of interstate Lake Tahoe, one of the clearest fresh-water mountain lakes in the world, is threatened by nitrogen and phosphorus pollutants in sewage and silt from land clearing operations within the Tahoe Basin.

When present above threshold levels in the lake, these nitrogen and phosphorus nutrients can stimulate algal growths and aquatic weeds that can produce surface scums and suspended turbidity which will drastically reduce the clarity and beauty of the lake waters and cause visual and olfactory nuisances. The phosphorus content of Lake Tahoe waters already approaches a critical level, and a substantial increase in nitrogen content could induce noxious algal blooms in Lake Tahoe. The nitrogen content in human wastes, that may drain into Lake Tahoe, poses the most serious threat to preservation and continued full enjoyment of this invaluable national resource.

The clarity of onshore waters is reduced where silt erosion from land clearing operations is transported into the lake by runoff during the rainy season.

The Lake Tahoe Basin is a scenic recreational wonderland for tourists, vacationists, visitors and residents alike. Lake Tahoe is used for public water supply, water-oriented sports such as boating, skiing, and fishing, and provides immeasurable aesthetic enjoyment to all who visit and support the economy of the area.

During the peak of summer recreational activity, population has grown from about 132,000 in 1962 to an estimated 180,000 in 1966. It is estimated that all available accessible land will have been developed by 2010, at which time the summer peak population is expected to reach 596,000.

Approximately 3,680 pounds of nitrogen per day and 489 pounds of phosphorus per day are presently contained in the sewage discharged within the Basin during the summertime. The major part of these loads, 62 percent of the nitrogen and 84 percent of the phosphorus, are discharged in the areas that are not served by community sewers. Nitrogen and phosphorus contained in sewage discharges will increase apace with increased population.

Public utility districts provide community sewers and treatment facilities in the more densely populated areas. Treated sewage containing nitrogen and phosphorus is discharged to spray irrigation and percolation disposal areas within the Basin.

Significant amounts of nitrogen (approximately 10 percent of all sources) and phosphorus (approximately 25 percent of all sources) are contained in refuse and garbage produced within the Basin.

The consultants* have concluded that after equilibrium has been reached, nitrogen contained in the effluents from municipal sewage treatment plants, residential septic tanks, and in refuse and garbage that is disposed of within the Basin will ultimately be transported into Lake Tahoe by surface drainage and subsurface seepage.

South Tahoe Public Utility District, the second largest source of nitrogen, discharges 29 percent of the sewage-associated nitrogen but only 1 percent of the phosphorus. Incline Village discharges 5.4 percent of the nitrogen and 8.2 percent of the phosphorus, while the North Tahoe Public Utility District discharges 4.4 percent of the nitrogen and 7.0 percent of the phosphorus. Effluent from the Tahoe City sewage treatment plant drains out of the Tahoe Basin.

At present (1966), approximately 1,090,000 pounds per year of nitrogen originate within, or enter, the Tahoe Basin with sewage, runoff, rain and refuse. Sewage accounts for almost one-half (47.5 percent) of this amount, and present sewage and refuse disposal practices eliminate only 12 percent of the total.

The amount of nitrogen contained in sewage will increase 5-fold by 2010, at which time it will account for approximately 75 percent of the 3,597,000 pounds per year of nitrogen sources in the Basin.

The 2010 nitrogen load may be reduced 50 percent, to 1,820,000 pounds per year, by conventional secondary treatment, or 92 percent, to 745,000 pounds/year if successful tertiary nitrogen-removing treatment

* McGauhey, Eliassen, Rohlich, Ludwig & Pearson.

processes are developed by that time. Rain and runoff alone will account for 530,000 pounds/year annually.

Objectionable blue-green algae and filamentous green algae are now present in some near-shore areas of Lake Tahoe. Also, the available phosphorus concentration in some near-shore areas is now at levels believed to be critical for the stimulation of algal growths. There are indications that algal growths may become obnoxious if the waters become further enriched.

ACKNOWLEDGEMENTS

The June 1963 report, "Comprehensive Study on Protection of Water Resources of Lake Tahoe Basin Through Controlled Waste Disposal, " *prepared for the Lake Tahoe Area Council by Board of Consultants, P. H. McGauhey, Rolf Eliassen, Gerard Rohlich, Harvey F. Ludwig, and Erman A. Pearson, has been used as the source of the basic and projected data referred to in this report.

Information concerning recent legislation, action by State and local authorities, and the status of sewage treatment practices at local public utility districts was provided by Irving M. Terzich, Sanitary Engineer, Southwest Regional Office, Federal Water Pollution Control Administration, Department of the Interior, San Francisco, California.

The valuable assistance provided by representatives of the California Department of Public Health, the California State and Lohontan Regional Water Pollution Control Boards, the Nevada Department of Public Health, the Nevada Department of Conservations and Natural Resources, County health departments and local public utility districts, and the Lake Tahoe Area Council is gratefully acknowledged.

* Referred to hereafter as the "Consultants' Report".

INTRODUCTION

Lake Tahoe, astride the California-Nevada state line in the Sierra Nevada Mountains, is one of the clearest, deepest freshwater lakes in the world. Situated at an elevation of 6,225 feet, Lake Tahoe is 192 square miles in area (122,880 acres) and has a length of 21.6 miles and a width of 12 miles. The lake's maximum depth is 1,645 feet, its mean depth is 990 feet, and its volume is approximately 122 million acre feet. The 1200-foot depth contour is often less than a mile from the nearest shore, and never more than three miles. The Tahoe drainage basin is 506 square miles.

Average annual precipitation in the Basin amounts to 27 inches per year, of which 60 percent is snow. Runoff from more than 60 tributary streams averages 307,900 acre feet, which when added to 205,000 acre feet of precipitation over the lake, amounts to 512,900 acre feet of water per year entering Lake Tahoe. The 332,000 acre feet/year average evaporation loss (32 inches/year) reduces the average net yield to 180,900 acre feet/year. There is no net yield during dry years when evaporation losses exceed precipitation and runoff.

Controlled discharge from Lake Tahoe into the Truckee River varied from a 656,900 acre feet/year maximum (1907) to a 4,700 acre feet/year minimum (1931) to average 176,000 acre feet/year during the 1901-1962 period of record. Approximately 5,000 acre feet/year are exported out of the Basin via the Marlette Lake, Third Creek and Echo Lake diversions.

As the growth of resident and tourist populations alike increases at an accelerated rate, the problems associated with sewage and other waste disposal are magnified and the rare clarity and beauty of Lake Tahoe waters are threatened by algal nuisances that may arise from the nitrogen and phosphorus contained in these wastes. Likewise, silt from land clearing practices and real estate development is an increasing problem.

This report discusses the nutrient and silt problems, the present status of sewage treatment and disposal, the water quality characteristics of lake waters, and the pollution abatement proposals designed to protect and preserve the quality and beauty of the interstate waters of Lake Tahoe.

WATER USES

Lake Tahoe, the sparkling jewel-like heart of this vacation wonderland, is the irreplaceable scenic attraction for campers, tourists and visitors alike, who flock to this mountain retreat in ever increasing numbers.

The shimmering crystal clear water soothes and relaxes those who come to view Lake Tahoe's magnificent splendor. It invigorates and rejuvenates those who boat, ski, fish and swim. It is a source of public water supply and, as the focus for recreational tourism, helps support the economy and welfare of those residing in both the California and Nevada sections of the Basin.

In 1962, 32 agencies, serving more than 16,000 persons, used Lake Tahoe as a source of domestic water supply. More than 8,000 persons receive water from systems that distribute lake water without treatment.

Approximately 48 percent of the land area in the Tahoe Basin is owned by the U. S. Forest Service and by State and County parks. The California-Nevada Interstate Park Commission is studying the feasibility of purchasing additional land along the east basin wall. These

lands, with facilities for picnicking and camping, are used extensively by tourists who visit the lake for boating, fishing, and water skiing.

It is imperative that this unique national resource be preserved and protected for full enjoyment by present and future generations.

SOURCES OF WASTES

INTRODUCTION

The nitrogen and phosphorus nutrients contained in sewage and other waste discharges within the Tahoe Basin threaten the splendor of Lake Tahoe.

When present above threshold levels in lake water, these elements can stimulate excessive algal and aquatic weed growths that may produce unsightly surface scums and suspended turbidity that can reduce drastically the clarity and beauty of lake waters.

Sewage-associated nutrient loads are increasing in proportion to the rapid population growth in the Basin. The number of people residing in the Lake Tahoe Basin varies throughout the seasons of the year according to the influx of tourists who visit the area to enjoy summer vacations, winter skiing and year-round gaming in this recreational area. Maximum population densities occur in August.

Summer peak and annual average population estimates for 1962, 1966 and 2010 are shown in the following table:

Year	Estimated Summer Peak Population	Annual Average as % of Summer Peak	Estimated Total Annual Average Population
1962	132,000	30	40,000
1966	180,000	32	58,000
2010	596,000	43	254,000

All sewage collected by community sewers is treated in plants which remove approximately 80 percent of the phosphorus but only 35 percent of the nitrogen. Sewage from residences not served by community sewers is discharged to septic tanks which remove little, if any, phosphorus or nitrogen. Effluents from the treatment plants are disposed of by spray irrigation or percolation, and those from septic tanks by subsurface seepage. The consultants conclude that, after equilibrium is reached, most of the nitrogen discharged to disposal areas within the Basin, including those serving individual residences, will be transported into the lake by surface drainage and subsurface seepage.

Refuse and garbage also contain significant amounts of nitrogen (approximately 10 percent of all sources) which can be transported to the lake by drainage and seepage unless exported out of the Basin.

During the rainy season, silt eroded from soils ripped up during land clearing and development is flushed into the lake and reduces the clarity of waters in the near-shore areas.

The types of sewage treatment provided in the Tahoe Basin is summarized as follows:

Estimated Connected Population (1966 Summertime Peak)	% of Connected Population	Type of Treatment
114,700 (unsewered areas)	64%	Privies, septic tanks, plus soil absorption
20,800 (Incline Village, No. Tahoe Pub. Util. Dist., Tahoe City)	11%	Public sewers, secondary treatment plus spray irrigation or soil absorption
44,500 (So. Tahoe Pub. Util. Dist., including Round Hill & Douglas Co. Utility Districts)	25%	Public sewers, tertiary treatment plus spray irrigation and soil absorption

Since these treatment facilities provide adequate protection against damage to water quality of the lake by other sewage constituents, such as oxygen-demanding organic matter and sewage bacteria, the discussion of pollutants in waste sources is limited to phosphorus, nitrogen and silt.

CORRECTIVE ACTION AND PROPOSALS

Approximately two-thirds of the estimated 1966 summertime population are not served by the existing municipal sewerage systems. Sewage from this major segment of the population is disposed of in privies or septic tanks which permit seepage of nitrogen and phosphorus into the subsoil formation that drain towards the lake.

Approximately one-third of the population is served by the following six public utility and improvement districts that provide community facilities for sewage collection, treatment and disposal:

California

South Tahoe Public Utility District

North Tahoe Public Utility District

Tahoe City Public Utility District

Nevada

Incline Village

Douglas County Sewer Improvement District

Round Hill General Improvement District

South Tahoe Public Utility District (STPUD)

The South Tahoe Public Utility District sewage treatment plant serves approximately 44,000 persons in the South Tahoe Public Utility District in California, and the Douglas County Sewer Improvement District and the Round Hill General Improvement District in Nevada. This treatment facility consists of conventional primary sedimentation with sludge digestion, secondary activated sludge biological treatment and chlorination. Additional tertiary treatment in the form of chemical treatment followed by sand filtration and contact in a carbon filter, is provided for phosphorus and organic nitrogen removal. Final effluent is equalized in a holding pond and then discharged to percolation beds and spray disposal areas in forested land.

These facilities were designed to treat two and one-half million gallons of sewage per day, but sewage flows have increased above design capacity to reach four million gallons per day during the summer of 1965.

During excessive flows, the effluent that could not be disposed of in the percolation beds overloaded and saturated the land areas used for spray disposal and a part of the treated effluent joined the natural surface runoff to Lake Tahoe.

The combined primary, secondary, and tertiary treatment facilities are designed to remove approximately 30 percent of the nitrogen and 98 percent of the phosphorus contained in the raw sewage.

The District has been granted at $1,800,000 State loan, has qualified for more than $3,000,000 in grants from the Federal Economic Development Agency and has authorized issuance of bonds for construction of additions to the treatment and disposal facilities. The District and the U. S. Forest Service are presently evaluating proposals for collection and transmission of sewage from the Pope-Baldwin Recreational Area to the STPUD facilities.

The District plans to expand the existing treatment facilities to provide seven and one-half million gallons per day capacity, proposes to construct an additional tertiary treatment plant for ammonia nitrogen removal, and expects to construct pumping and transmission facilities to transport the final effluent out of the Basin over Luther Pass and into Alpine County, California, for ultimate disposal to spreading beds in the Carson River Valley below Woodfords.

North Tahoe Public Utility District (NTPUD)

The North Tahoe Public Utility District sewage treatment plant, serving approximately 8,000 persons, consists of primary sedimentation with separate sludge digestion and chlorination facilities. Treated effluent is disposed of by percolation in trenches which, because of their large capacity, presently serve as waste stabilization ponds to provide the equivalent of secondary treatment prior to ultimate ground disposal.

Tests in 1962 indicated that these primary treatment facilities removed approximately 23 percent of the nitrogen and 16 percent of the phosphorus contained in the raw sewage.

The District is considering joining a proposed enlarged North Shore Public Utility District for exporting of all sewage out of the Basin.

Tahoe City Public Utility District

The Tahoe City Public Utility District sewage treatment facilities, serving approximately 1,700 persons, consists of primary sedimentation with separate sludge digestion followed by a secondary trickling filter plant. The effluent is disposed of by spray irrigation and percolation trenches. The disposal area is located in the Truckee River Basin and therefore no effluent reaches the Tahoe Basin. This area is also considering joining the proposed North Shore Public Utility District.

Incline Village

The Incline Village sewage treatment facilities, serving approximately 11,100 persons, include an activated sludge type secondary treatment process equipped for chlorination and diatomite filtration of the effluent. The effluent is stored in reservoirs and then discharged to a sprinkler system at the local golf course or to a spray disposal system in the nearby woods.

It is estimated that the secondary treatment facilities remove approximately 52 percent of the nitrogen and 40 percent of the phosphorus contained in the sewage.

The State of Nevada proposes to enact enabling legislation which would, in effect, permit Incline Village to join public utility districts in California. Incline Village will consider joining the proposed North Shore Public Utility District if appropriate State-enabling legislation is passed.

Douglas County Sewer Improvement District and
Round Hill General Improvement District

Sewage from these two districts is presently discharged to the adjacent South Tahoe Public Utility District collection system for treatment and ultimate disposal.

These two districts plan to combine in a joint venture to collect and treat sewage from the two districts and export the treated effluent out of the Basin over Daggett Pass into the drainage basin of the Main Carson River in Nevada. The Districts have voted bonds (Douglas County,

3.0 million dollars; Round Hill, 3.0 million dollars) for their share of the costs. They have been offered a $700,000 F.W.P.C.A. construction grant for 1966, and the State of Nevada proposes to allow an additional $800,000 of anticipated 1967 F.W.P.C.A. construction grant funds to assist in completion of the sewage treatment plant and effluent export system.

Proposed Enlarged North Shore Area Public Utility District

Residents of the North Tahoe Public Utility District, the Tahoe City Public Utility District, and other unsewered areas along the north and west shores of the lake are considering formation of a proposed enlarged inclusive North Shore Area Public Utility District. The District would extend from Bliss State Park in Eldorado County in California to the California-Nevada State line, and would include the two existing public utility districts and all contiguous land areas. Incline Village could be included in the proposed new district if Nevada passes appropriate enabling legislation.

This plan includes collection of all sewage within the District boundaries in the Tahoe Basin. A transmission line along the Truckee River would convey this sewage, and sewage from Alpine Meadows, Squaw Valley, Donner Lake, and the city of Truckee, California to a proposed secondary treatment plant near Truckee, California. According to the plan, treated effluent would be pumped to a disposal area in Martis Valley where it would percolate to mingle with the ground water and ultimately appear in the Truckee River.

Governmental Agencies and Local Associations

Local and State associations, and government agencies having an interest in the lake, recognize the need to abate pollution that threatens Lake Tahoe, and have accepted the consultants' recommendation that sewage treatment plant effluents should be exported out of the Basin. Engineering investigations have been completed, field studies continue, sanitation ordinances are in effect, interstate compact groups have been organized, enabling legislation has been passed, and sewage treatment plants have been constructed. Though commendable progress has been made, the complex pollution problem remains and is intensified by accelerated residential, recreational and commercial growth in the Basin.

State and local action, directed towards ultimate solution of the pollution problem. is summarized as follows:

State Agencies

1. Regulatory agencies in both California and Nevada prohibit the discharge of wastes or waste effluents which would reach either Lake Tahoe or the Truckee River by surface flow.

2. Senate Bill No. 22 adds Section 13065 to the California State Water Code. This section of the Water Code prohibits the use of cesspools or other means of sewage or industrial waste disposal in any district of the Lake Tahoe Basin where a waste collection system, treatment facilities and export of the treated effluent from the Basin are provided.

3. Assembly Bill No. 2618 (Chappie, Lunardi) Regular Session, 1965, adds Section 1, Division 22 (Sections 77000 to 84700) to the California State Water Code. This is enabling legislation permitting the formation of sanitation authorities by two or more public agencies (without requirement of contingency) to provide sewerage facilities.

4. Nevada is considering enactment of enabling legislation which would in effect permit Incline Village in Nevada to join the North Shore Public Utility District (when formed) in California for the collection, treatment and disposal of sewage.

5. Representatives, one for the State of California and one for the State of Nevada, were appointed to assist local agencies, assess progress in the Basin, and report to and advise the State governors on all matters pertaining to the protection of the quality of waters in the Tahoe Basin and to recommend such action as may be necessary.

Mr. John T. Leggett, executive officer of the Lahontan Regional Water Quality Control Board, was appointed for California and Mr. Wallace W. White, Director of the Nevada State Department of Health and Welfare was appointed for Nevada.

6. A California-Nevada Joint Interstate Compact Commission has been formed to develop a compact for allocation of the waters of Lake Tahoe and the Truckee, Carson and Walker rivers.

Representatives of the Federal Water Pollution Control Administration have supported the intent of the provisional compact to maintain existing excellent water quality of the interstate waters, but objected

to provisions that would require that no waste waters be exported from the Lake Tahoe Basin without permission of the compact commission. The F.W.P.C.A. contend that the export of waste waters is essential at this time to protect the extraordinary clarity of Lake Tahoe and that certain conditions in the provisional compact, particularly those relative to preventing a reduction of flow available to the Truckee River water users, could delay and perhaps even preclude the export of waste waters.

7. Senate Bill No. 17 of the California Legislature authorizes a loan fund in the amount of 1.8 million dollars to the South Tahoe Public Utility District to permit the extension of export facilities from the summit of Luther Pass to Diamond Valley in Alpine County, California.

8. A California-Nevada Joint Water Quality Investigation group collects chemical, biological, and microbiological samples from stations on the lake four times per year to monitor water quality and report changes or trends that may become evident. The Federal Water Pollution Control Administration assists this group by analyzing the biological samples.

Placer County

The Placer County, California, Board of Supervisors engaged Engineering-Science, Inc. to study waste disposal alternatives for the North Shore area of Lake Tahoe. In the February 1965 report to the Board of Supervisors, Engineering-Science, Inc. delineated logical public utility district

boundaries, provided cost estimates, and discussed the relative merits of alternate schemes for exporting North Shore sewage out of the Basin.

Lake Tahoe Area Council

The Lake Tahoe Area Council has engaged a nationally recognized board of consultants to study and report on sewage and waste problems in the Basin and recommend means to protect the clarity and beauty of Lake Tahoe.

This and other projects were aided by grants from the Max Fleischmann Foundation.

Basic information, evaluations, and recommendations by the board of consultants are given in the consultants' June 1963 report, "Comprehensive Study on Protection of Water Resources of Lake Tahoe Basin Through Controlled Waste Disposal." The consultants' report includes population statistics, nitrogen and phosphorus loads in sewage and refuse for 1962, and estimates the natural and man-made nutrient loads that may prevail in the Year 2010. It discusses the effects of nutrients on lake waters, and concludes that refuse and sewage treatment plant effluents should be exported from the Basin to provide an immediate correction for water pollution problems within the Basin.

The Council has received an additional $17,500 grant from the Max Fleischmann Foundation to finance an additional engineering study to implement a comprehensive basin-wide plan for exporting sewage and sewage treatment plant effluents from the Basin.

The Council has also received a Federal Water Pollution Control Administration demonstration grant in the amount of $74,000 to determine the kind and amounts of nutrients and growth stimulants which tend to start or encourage the growth of algae in freshwater lakes. Pilot scale tests will be made to determine the sensitivity of Lake Tahoe waters to sewage treatment plant effluent, septic tank effluent, surface wash from natural vegetated areas and pollutants resulting from land or shoreline management activities of various kinds. The project will be conducted by the Lake Tahoe Area Council's board of consultants, headed by Professor P. H. McGauhey of the University of California at Berkeley.

Present Status of the Problem

Despite present accomplishments, areas responsible for approximately two-thirds of the sewage-associated nitrogen discharges are not served by community sewers or treatment facilities; sewage flows exceed the capacity of the South Tahoe Public Utility District's treatment plant, and sewage plant effluents are still disposed of within the Basin. Nutrients from these sources in Nevada and California continue to threaten the beauty and full enjoyment of Lake Tahoe and endanger the welfare of both California and Nevada residents of the Basin.

NITROGEN AND PHOSPHORUS IN SEWAGE (1966 SUMMER PEAK POPULATION)

The estimated 1966 summertime peak nitrogen and phosphorus loads in treated and untreated sewage originating within the Tahoe Basin are summarized in Table I and illustrated on Figure 2.

Untreated Sewage

The major source of sewage-associated nitrogen and phosphorus originates in areas not served by the community sewers and treatment systems (Figure 2, Table I). The unsewered areas include the residences provided with septic tanks and the camp sites which are furnished with chemical pit privies. Approximately 62 percent of all nitrogen and 84 percent of all phosphorus in sewage discharges originates from these unsewered areas. The urgent need for basin-wide community sewerage systems, for effective nutrient removal, is accentuated by this disproportionately large nutrient load from the unsewered areas.

Treated Sewage

Effluent from the South Tahoe Public Utility District sewage treatment plant, which also serves the Bond Hill and Douglas County Improvement Districts, is the second largest source of sewage-associated nitrogen. The effluent from this plant contains 29 percent of the nitrogen, but only 1 percent of the phosphorus.

Treated sewage from Incline Village contains 5.4 percent of the nitrogen and 8.2 percent of the phosphorus, while that from the North Tahoe Public Utility District plant contains 4.4 percent of the nitrogen and 7 percent of the phosphorus.

Effluent from the Tahoe City sewage treatment plant drains into the Truckee River Basin and therefore does not contribute nitrogen or phosphorus to the Tahoe Basin.

TOTAL NITROGEN AND PHOSPHORUS SOURCES IN THE BASIN
(1966 and 2010 AVERAGE ANNUAL)

Nitrogen

Present Loads (1966 estimates)

In 1966 almost half (47.5 percent) of the 1,090,000 pounds per year of nitrogen produced by all sources originated in sewage, 8.1 percent originated in refuse and the remaining 44.4 percent came from rain and runoff. (Figure 3, Table II)

Current sewage treatment practices, which remove only 17 percent of the nitrogen in sewage on the average, do not effectively protect the Basin against nitrogen pollution from man-made sources. Sewage treatment, and export of approximately one-half of the refuse, will remove only 12 percent of the nitrogen, and allow 958,000 pounds per year to be discharged within the Basin.

Future Loads (2010 estimates)

The consultants estimate that practically all suitable accessible lands will have been developed by 2010, at which time the peak summertime population will have increased to about 600,000 persons and the average annual population will have increased to 254,000. By that time the total nitrogen sources will have increased to approximately 3,597,000 pounds per year. Approximately 75 percent of this total will originate in sewage, 11 percent in refuse and the remaining 14 percent in rain and runoff.

Sewage flows will increase apace with population growths, and the nitrogen in untreated sewage sources alone will have increased five-fold to approximately 2,700,000 pounds per year by 2010, and will amount to 75 percent of the total 3,600,000 pounds per year nitrogen load from all sources. (Figure 3, Table III)

Even when conventional secondary treatment is provided for all sewage, the 2010 total net nitrogen discharges to the Basin would double the present 1966 load and contribute 1,820,000 pounds of nitrogen per year to the Basin.

If efficient practical nitrogen-removing tertiary processes can be developed for full scale use in 2010, the total nitrogen load may be reduced to 745,000 pounds per year. A residual of approximately 530,000 pounds per year in rain and runoff would remain if all sewage and wastes were exported out of the Basin.

Phosphorus

Figure 4 illustrates the phosphorus loads in the Basin. In 1966, the 183,800 pounds per year source of phosphorus is reduced 31 percent, to 126,500 pounds per year, by sewage treatment and by exporting about 50 percent of the refuse. (Figure 4, Table II)

The total amount of phosphorus from all sources is estimated to increase approximately four times by the year 2010; at which time approximately 720,000 pounds per year will be produced in the Basin. Based on the successful experience at the South Tahoe Public Utility District,

98 percent phosphorus removal may be obtained from properly designed and operated tertiary treatment plants. It is estimated, therefore, that approximately 72,000 pounds of phosphorus per year, which would amount to 57 percent of the 1966 load, would be discharged within the Basin in 2010, providing all refuse were exported from the Basin and all sewage received appropriate tertiary treatment. The estimated load could be reduced to 53,000 pounds per year if all sewage were exported out of the Basin.

EFFECTS OF WASTES ON WATER QUALITY AND USE

EUTROPHICATION

Eutrophication refers to the enrichment of waters by nutrients through man-created or natural means. Natural enrichment produces a rate of lake aging that may be measured only by the clock of geologic time. Additional fertilization accelerates this rate, making changes in water quality that are noticeable within a few decades or even less. It is obvious, for example, that growing cities and expanding industries are pouring nutrients into the Nation's waterways at an accelerating rate, and that aquatic weed and algal nuisances have increased in areas where they did not exist before, and have magnified in areas where there was only a tolerable growth.

The scope of accelerated eutrophication, or water enrichment, is broad. The most perceptible characteristics to the layman include change in water color, increase in turbidity, nuisance growths of small suspended plants or algal scums, developing areas of rooted water plants, and odors associated with decaying dead vegetation. More

subtle changes can be found by the scientific investigator as indicated by decreased light penetration; decreased dissolved oxygen in deeper waters; increased nitrogen and phosphorus concentrations, especially in the deeper waters; significant changes in the algal population, the kinds and numbers of bottom-dwelling organisms and fish, and increased rooted aquatic weed beds.

Present knowledge indicates that the fertilizing elements contributing most to lake eutrophication are nitrogen and phosphorus. Iron is also important. Vitamins such as B_{12}, many micronutrients, and extracellular products from existing plant populations play a role in the developing aquatic plant growths, but this role is not presently well understood. Sewage and sewage effluents contain generous amounts of those nutrients necessary for abundant algal development.

Many eutrophic lakes throughout the country and the world have been fertile reservoirs for algal development for many years. Notable among these in the United States are Lake Zoar in Connecticut, Lake Sebasticook in Maine, the Madison Lakes in Wisconsin, Lake Erie, the Detroit Lakes in Minnesota, Green Lake and Lake Washington in Washington, and Klamath Lake in Oregon.

As nutrient concentrations increase, the numbers of algal cells usually increase. Nuisance conditions, such as unsightly surface scums and algal-littered beaches, occur. The water may become foul-smelling. Filter-clogging problems may occur at municipal water treatment

plants. Filamentous algae, especially Cladophora, grow profusely on nearly any suitable subsurface. These can cause nuisances when they break loose and wash ashore to form windrows of stinking vegetation. Induced acceleration of this normally slow natural process is not in the best interests of man.

At the present time, the waters of Lake Tahoe are not enriched, nor do they support dense algal populations. Threats of future problems are serious, however. The phosphorus concentration in some near-shore areas is now at a critical level for the stimulation of algal growths, and all of the phosphorus present as shown by analytical tests is available for algal utilization. Available nitrogen concentration is presently low and is believed to be the major nutrient limiting algal development beyond the lake's present capacity. Potentially nuisance-producing blue-green algae and filamentous green algae are now present in some near-shore areas of the lake. Furthermore, the impact of nutrients from inflowing streams on the lake water was demonstrated by increased phosphorus concentrations and, in some cases, increased algal concentrations. Presently, this impact is limited to the near-shore waters surrounding the stream's mouth.

SILT

Silt, eroded from lands where the natural vegetative cover has been destroyed during land clearing operations, is transported into Lake Tahoe by runoff during the rainy season.

Clearing and excavation of land for housing and commercial development, timber harvest, sand and gravel mining, highway construction and other land uses that disturb the ground surface can create or intensify soil erosion problems. Newly exposed ground surfaces and disturbed duff contribute increased amounts of dissolved nitrogen and phosphorus to the runoff. Silt, reaching the lake during runoff, increases the turbidity and reduces the clarity of onshore waters and increases bottom deposits that can smother fish food organisms.

Soil erosion and silt transport can be reduced by seasonal scheduling of land clearing projects to permit restoration or stabilization of disturbed soils before they are subjected to the severe impact of heavy storms during the rainy season. Diversion dykes or channels provided upslope from areas scheduled for clearing can divert runoff around the work area and reduce erosion of the disturbed soils. Where applicable, silt collection basins, or cut-off dams, below work areas can reduce silt transport and prevent gully formation. All disturbed soils should be stabilized, restored or planted with flow retarding vegetative cover as soon as possible. Excavated material should be properly disposed of to prevent its being flushed into the lake or tributary watercourses.

Provision of temporary cut-off walls at the lake shore during construction of new boat channels extending from the lake into marinas or residential and commercial developments can minimize the transport of suspended silt from the construction site into the lake. Newly constructed banks should be stabilized and made impervious to erosion and scour.

Road and highway cut and fill slopes should be stabilized and revegetated. Highway drainage facilities should be provided with properly designed impervious inlet and outlet structures that will effectively prevent erosion and undermining at these critical locations.

Logging should be conducted according to approved forest management practices to preclude rapid detimbering of large areas and repeated use of the same skid trails. Protective strips of undisturbed land should be allowed to remain on each side of permanent streams.

The silt pollution problem, which can also be magnified by increased population growth and more intensive land use within the Basin, should be abated by following appropriate effective soil conservation and erosion control practices in all present and future land development operations.

PHYSICAL FEATURES

Temperature data indicate that the lake stratifies and that a thermocline (a zone of greatest vertical temperature change) occurs at a depth of 50 to 70 feet during the summer months. Complete overturn of the waters of Lake Tahoe has not been observed but may occur during winters of unusual severity.

Observations have been made on the transparency of the water in the lake by viewing a white disc, approximately 8 inches in diameter, as it was lowered in the water. The white disc was observed to a depth of 136 feet at one of the stations on April 4, 1962. This may be compared to a transparency value of 5 feet, or less, in an eutrophic lake with a heavy algal bloom. A minimum transparency of 49 feet was observed in Emerald Bay of Lake Tahoe on May 21, 1962; this was associated with a relatively high concentration of plankton at the time the measurement was made. Transparency measurements have been made on several occasions over the years on Lake Tahoe by different investigators. No significant long-term trend in the transparency of the lake can be detected from observations made during the past 90 years.

CHEMICAL DATA

Samples were collected both seasonally and at various depths from 13 general sampling locations (Figure 5). These were divided into offshore stations (Stations 1 through 4 with depths greater than 150

feet) and near-shore stations (Stations 5 through 13 with depths less than 150 feet). The data indicate in general only minor differences in chemical composition from the water's surface, mid-depth, and bottom. A seasonal change among May, July, September and December samples with respect to depth also was not evident generally.

The average alkalinity was 45 mg/l as calcium carbonate and the minimum value was 41 mg/l. Likewise, the pH varied only from 8.3 to 7.3 and averaged 7.8 (Table IV).

Two of the major nutrients, nitrogen and phosphorus, are always of interest in connection with lake investigations because of their role in biotic production and in nuisance plant growths. Samples were analyzed from 12 offshore sampling points and 45 near-shore points for nitrate nitrogen (N) and soluble phosphorus (P) during both May and July (Table IV). Nitrate nitrogen was present in an average concentration of 9.2 µg N/l (parts per billion) in May and 8.0 µg N/l in July in the offshore areas, and 6.4 µg N/l during both months at the near-shore stations. Concentrations of ammonia nitrogen, nitrite nitrogen and organic nitrogen were below the analytical limits. The average concentration of soluble phosphorus was 5.1 and 10.9 µg P/l in May and July respectively in the offshore areas and 6.1 and 8.7 µg P/l in May and July respectively in the near-shore areas. No significant difference between concentrations of soluble and total phosphorus was found, indicating that all phosphorus was in the soluble form.

The nitrogen values are very low whereas the phosphorus values closely approach those believed to be critical for algal blooms. Of these two major nutrients, nitrogen would appear to be limiting to algal development. Total phosphorus concentrations were generally higher in July than in May because of higher values at some near-shore and deep-water points. These higher values may be due either to the liberation of phosphates from the littoral sediments or to the influence of tributary streams and pollution from man's activities. Areas 6, 8, and 13 (Figure 5) were chosen to investigate possible effects of stream discharge on the nitrogen and phosphorus concentration of near-shore waters and effects on plankton concentrations resulting from such discharges. The concentration of phosphorus was increased in the near-shore waters by these streams, but the increase was not evident generally at a distance of 600 or 700 feet from shore. In area 7, a small craft harbor at Tahoe City, the total phosphorus concentration in July was increased by 2 to 3 times that in May, possibly by man's activities, and the phytoplankton (algal) concentration responded with a similar increase to 3,890 organisms per milliliter in July.

BIOLOGICAL CONDITIONS

A total of 39 samples was collected from a depth of about 100 feet for plankton counts (Table 5) and for chlorophyll determinations. Essentially all of the phytoplankton were diatoms. All counts were less than 500 organisms per ml with the exception of near-shore areas

7, 12 and 13 (Tahoe City boat harbor, Bijou and upper Truckee River inlet area). The Tahoe City boat harbor had 1,260 organisms per ml in April and 3,890 in July; both are considered algal blooms.

At the time that phytoplankton collections were made, water samples were analyzed for chlorophyll; the July results are shown in Table VI. Chlorophyll is the green coloring matter in plants, and chlorophyll in water samples is indicative of the presence of algae. Although chlorophyll a concentrations are considered low with a maximum July concentration of 1.74 mg/m^3 (milligrams per cubic meter), areas where the chlorophyll a concentrations are greatest are located around the south and east near-shore stations and at offshore area 4 (Figure 6). Other areas of the lake have values less than 0.3 mg/m^3.

Organisms that are able to attach themselves to the surface of an object were studied by means of microscopic glass slides that were suspended in the lake water at different depths and removed at weekly intervals and examined microscopically. Bacteria outnumbered all other organisms and in some cases were the only organism found.

Although organisms of the type that produce objectionable growths such as filamentous algae, including blue-greens, are already present in near-shore areas, they are not now excessive because of low nutrient concentrations and a resulting low growth rate.

Lake Tahoe contains 122 million acre feet of water that now does not support nuisance algal blooms. It could support these obnoxious growths in many areas if further enriched. It is imperative that the man-associated nutrients not be permitted to enter the lake if Lake Tahoe is to remain clear and beautiful.

APPENDIX

Table I

NITROGEN & PHOSPHORUS CONTENT OF SEWAGE

Estimated 1966 Summertime Peak Load

Tahoe Basin

SOURCE	POPULATION		FLOW	RAW SEWAGE			REMOVALS		RESIDUAL LOAD TO BASIN	
	Number	% of Total	(MGD)	(mg/l)	(lbs./day)	% of Total	(%)	(lbs./day)	(lbs./day)	% of Total
NITROGEN (as N)										
Treated Sewage										
South Tahoe PUD	44,500	24.7	4.00	45	1,500	33.7	30	450	1,050	28.6
Incline Village	11,100	6.2	1.00	45	416	9.3	52	216	200	5.4
North Tahoe PUD	8,000	4.4	0.72	35	210	4.7	23	48	162	4.4
Tahoe City	1,700	1.0	0.15	45	56	1.3	100*	56	0	0
Subtotal	65,300	36.3	5.87	45	2,182	49.0	35	770	1,412	38.4
Untreated Sewage	114,700	63.7			2,268	51.0	0	0	2,268	61.6
Totals	180,000	100.0			4,450	100.0	17.3	770	3,680	100.0
PHOSPHORUS (as P)										
Treated Sewage										
South Tahoe PUD	44,500		4.00	8	267	33.6	98	262	5	1.0
Incline Village	11,100		1.00	8	67	8.4	40	27	40	8.2
North Tahoe PUD	8,000		0.72	6.8	41	5.2	16	7	34	7.0
Tahoe City	1,700		0.15	8	10	1.3	100*	10	0	0
Subtotal	65,300		5.87	8	385	48.5	80	306	79	16.2
Untreated Sewage	114,700				410	51.5	0	0	410	83.8
Totals	180,000				795	100.0	38.5	306	489	100.0

* Tahoe City plant provides conventional secondary treatment; but all effluent drains out of Tahoe Basin.

NOTE: Tabulated results were extrapolated from data and information in "Consultants' Report".

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Table II

ESTIMATED SOURCES OF NUTRIENTS
IN TAHOE BASIN
(Present - 1966 - 58,000 Average Annual Population)

Source	Total Sources (Before Treatment or Removal) Pounds/Yr.	% of Total	Removal by Treatment or Disposal %	Net to Basin (After Treatment or Removal) Pounds/Yr.	% of Total
Nitrogen (as N)					
Run-off	262,000	24.0	0	262,000	27.3
Rain	222,000	20.4	0	222,000	23.2
Subtotal	484,000	44.4	0	484,000	50.5
Refuse	88,000	8.1	50	44,000	4.6
Sewage	518,000	47.5	17	430,000	44.9
Subtotal	606,000	55.6	22	474,000	49.5
Total	1,090,000	100.0	12	958,000	100.0
Phosphorus (as P)					
Run-off	47,000	25.6	0	47,000	37.2
Rain	Trace	0	0	Trace	0
Subtotal	47,000	25.6	0	47,000	37.2
Refuse	44,000	23.9	50	22,000	17.4
Sewage	92,800	50.5	38	57,500	45.4
Subtotal	136,800	74.4	42	79,500	62.8
Total	183,800	100.0	31	126,500	100.0

NOTE: Tabulated results were extrapolated from data and information in "Consultants' Report".

Table III

ESTIMATED SOURCES OF NUTRIENTS
IN TAHOE BASIN

(Year 2010 - 254,000 Average Annual Population)

	TOTAL SOURCES Before Treatment Lbs./Yr.	% of Total	NET TO BASIN After Secondary Treatment % Reduction	Lbs./Yr.	% of Total	NET TO BASIN After Tertiary Treatment % Reduction	Lbs./Yr.	% of Total
Nitrogen (as N)								
Run-off	308,000	8.5	0	308,000	16.9	0	308,000	41.3
Rain	222,000	6.2	0	222,000	12.2	0	222,000	29.8
Subtotal	530,000	14.7	0	530,000	29.1	0	530,000	71.1
Refuse	383,000	10.7	100	0	0	100	0	0
Sewage	2,684,000	74.6	52	1,290,000	70.9	92	215,000	28.9
Subtotal	3,067,000	85.3	58	1,290,000	70.9	93	215,000	28.9
Total	3,597,000	100.0	50	1,820,000	100.0	80	745,000	100.0
Sewage as % of Natural	(507%)			(244%)			(41%)	
Phosphorus (as P)								
Run-off	53,000	7.4	0	53,000	15.6	0	53,000	73.6
Rain	Trace	0	0	Trace	0	0	Trace	0
Subtotal	53,000	7.4	0	53,000	15.6	0	53,000	73.6
Refuse	191,000	26.5	100	0	0	100	0	26.4
Sewage	477,000	66.1	40	286,000	84.4	96	19,000	0
Subtotal	668,000	92.6	57	286,000	84.4	97	19,000	26.4
Total	721,000	100.0	53	339,000	100.0	90	72,000	100.0
Sewage as % of Natural	(900%)			(540%)			(36%)	

Note: Total Sources and Percent Removals according to "Consultants'" estimates.
Assuming that all garbage is exported out of Basin.

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TABLE IV

NITROGEN, PHOSPHORUS, ALKALINITY AND pH OF LAKE TAHOE (1962)

Station	Date	Depth m	Alkalinity as $CaCO_3$ mg/l	Nitrate N µg N/l	Soluble P µg P/l	pH
1	Apr 29	0	40	6.7	6.0	7.6
		200	39	6.7	6.0	7.6
		400	38	14.1	5.0	8.2
	July 19	0	43	6.3	7.5	7.6
		200	41	6.3	5.0	7.4
		400	45	6.0	5.0	7.4
2	May 5	0	40	6.7	7.5	8.0
		200	41	6.7	4.0	7.9
		400	41	6.7	4.0	7.9
	July 17	0	43	6.3	6.0	7.6
		200	43	7.0	5.0	7.5
		400	45	13.0	25.0	7.3
3	May 5	0	40	10.0	5.0	8.0
		200	41	10.0	5.0	7.9
		400	40	14.0	5.0	7.9
	July 17	0	45	6.3	16.0	7.6
		200	43	6.9	17.0	8.0
		400	43	6.5	24.0	7.4
4	Apr 29	0	41	6.7	5.0	8.3
		250	40	6.7	4.0	8.3
		500	40	16.0	5.0	8.2
	July 17	0	44	6.3	4.0	7.5
		250	43	6.3	9.0	7.6
		500	43	6.9	7.5	7.3
5	Apr 28	0	32	6.7	4.0	7.8
		30	33	6.7	5.0	8.2
		60	33	6.7	5.0	8.2

(Continued)

TABLE IV (Continued)

Station	Date	Depth m	Alkalinity as $CaCO_3$ mg/l	Nitrate N µg N/l	Soluble P µg P/l	pH
	July 19	0	29	6.3	7.5	-
		30	33	6.9	5.0	-
		60	33	7.0	12.0	-
6a	Apr 29	1	21	6.0	10.0	7.6
	July 18	1	37	7.0	17.0	7.7
6b	Apr 29	2	27	4.5	7.5	-
	July 18	2	42	6.9	4.0	-
6c	Apr 29	1	41	6.7	6.5	7.9
		25	40	6.7	4.0	7.8
		50	41	6.7	5.0	7.8
	July 18	1	42	6.3	6.0	7.6
		25	42	6.3	10.0	7.6
		50	43	10.7	5.0	7.6
6d	Apr 29	3	41	7.5	5.0	7.8
	July 18	3	43	-	-	7.7
6e	Apr 29	2	40	6.0	5.0	7.8
	July 18	2	43	6.3	6.0	7.7
	Apr 29	2	-	5.4	5.0	-
	July 17	2	43	6.3	13.0	7.6
7a	Apr 29	1	41	5.4	9.0	7.8
	July 17	1	43	6.3	15.0	7.6
7b	Apr 29	1	40	6.7	5.1	7.8
		10	44	4.7	5.0	7.5
	July 17	1	43	6.3	15.0	7.7
		10	44	6.3	17.0	7.7
8a	Apr 30	1	-	4.5	4.0	-
	July 18	1	44	6.5	17.0	-
8b	Apr 30	2	-	5.4	6.0	-
	July 18	2	42	6.0	20.0	7.7

(Continued)

TABLE IV (Continued)

Station	Date	Depth m	Alkalinity as $CaCO_3$ mg/l	Nitrate N µg N/l	Soluble P µg P/l	pH
8d	Apr 30	4	-	7.5	7.5	-
	July 18	4	42	6.3	7.5	7.6
8e	Apr 30	1	41	5.4	4.0	7.9
		8	41	4.7	5.0	7.9
		16	42	3.3	5.0	8.3
	July 18	1	42	6.3	4.0	7.6
		8	43	6.0	5.0	7.5
		16	43	6.8	7.5	7.6
8f	Apr 30	1.5	-	9.0	7.5	-
	July 18	1.5	43	6.3	4.0	7.8
8g	Apr 30	2	-	5.4	-	-
	July 18	2	43	6.9	-	7.6
9a	Apr 30	1	-	7.5	9.0	-
	July 18	1	43	5.9	7.5	7.7
9b	Apr 30	4	-	7.8	6.0	-
	July 18	4	43	6.0	7.5	7.6
		8	42	6.5	7.5	7.6
9c	Apr 30	1	41	3.3	6.5	7.9
		45	41	6.7	5.0	7.9
		90	41	6.7	5.0	7.9
	July 18	1	41	6.3	2.5	7.6
		45	43	6.3	10.0	7.6
		90	43	-	9.0	7.6
10 a	Apr 30	2	-	5.4	5.0	-
	July 18	2	43	6.3	6.5	7.7
10b	Apr 30	2	-	-	-	-
	July 18	2	-	6.3	7.5	7.6
		100	-	6.3	6.0	7.6
10c	Apr 30	1	41	6.7	4.0	7.9
		60	41	6.7	5.0	7.9

(Continued)

TABLE IV (Continued)

Station	Date	Depth m	Alkalinity as $CaCO_3$ mg/l	Nitrate N µg N/l	Soluble P µg P/l	pH
		120	40	6.7	5.0	7.9
	July 18	1	44	6.3	6.0	7.6
		60	43	7.3	5.0	7.5
		120	43	7.5	5.0	7.5
11a	May 5	1	44	6.0	8.0	7.8
11b	May 5	3	42	4.5	7.5	7.9
	July 18	3	43	6.5	7.5	7.7
11c	May 5	1	42	7.5	10.0	7.9
		9	41	5.4	9.0	7.9
	July 18	1	43	6.0	5.0	-
		9	43	6.0	6.0	-
11d	May 5	1	40	6.7	5.0	8.0
		37	40	6.7	5.0	7.9
		75	41	6.7	5.0	7.9
	July 18	1	42	6.5	7.5	7.7
		37	42	6.3	7.5	7.6
		75	43	6.5	7.5	7.7
12	May 6	1	38	6.7	7.5	7.8
	July 19	1	44	5.2	6.0	7.6
13a	May 5	1	40	6.0	9.0	7.8
	July 19	1	46	5.2	13.0	7.8
13b	May 5	1	40	6.0	10.0	7.9
	July 19	1	43	5.2	10.0	7.6
13c	May 5	1	40	6.7	5.0	7.9
		5	39	6.7	5.0	7.8
	July 19	1	43	6.0	10.0	7.7
		5	42	6.3	17.0	7.6
13d	May 5	1	40	8.4	5.0	7.7
	July 19	1	42	5.4	10.0	7.9
13e	May 5	1	40	9.0	7.5	7.9
	July 19	1	42	5.0	7.5	7.7

(Continued)

TABLE IV(Continued)

SUMMARY

	N µg N/l	P µg P/l
Offshore (Stations 1 thru 4)		
Number of Samples		
May	12	12
July	12	12
Avg. Concentration		
May	9.2	5.1
July	8.0	10.9
Nearshore (Stations 5 thru 13)		
Number of Samples		
May	45	44
July	46	45
Avg. Concentration		
May	6.4	6.1
July	6.4	8.7
All Stations (1 thru 13)		
Number of Samples		
May	57	56
July	58	57
Avg. Concentration		
May	7.0	5.9
July	6.7	9.2

NOTE: Data from Table in Appendix "G" of "Consultants' Report".

TABLE V

CONCENTRATION OF PHYTOPLANKTON IN LAKE TAHOE (1962)

Station	Collection Date	Org/ml
1	April 29	245
	July 19	54
2	May 5	127
	July 17	26
	Sept. 21	26
	Sept. 13	66
3	May 5	177
	July 17	37
4	April 29	212
	July 17	13
	Sept. 21	13
5	April 28	76
	July 19	33
6c	April 29	185
	July 18	119
7	April 29	1,260
	July 17	3,890
7b	April 29	105
	July 17	148
8e	April 30	118
	July 18	68
	Sept. 20	61
8g	April 30	167
9c	April 30	104
	July 18	61
10c	April 30	195
	July 18	58
11d	May 5	164
	July 18	63
12	May 6	262
	July 19	578
13a	July 19	457

(Continued)

TABLE V (Continued)

Station	Collection Date	Org/ml
13b	July 19	1,400
13c	May 5	107
	July 19	70
	Sept. 21	29
	Dec. 13	38
13d	July 19	794
13e	July 19	286

NOTE: Reproduction of Table 11-XL, pg 84 of the "Consultants' Report".

TABLE VI

JULY

CHLOROPHYLL *a* CONCENTRATIONS IN LAKE TAHOE

Sampling Area	Chlorophyll *a* mg/m^3
1	0.21
2	0.15
3	0.13
4	1.74
5	0.10
6	0.17
7	0.19
	0.18
8	0.24
9	0.19
10	0.35
11	0.38
12	0.50
13a	1.09
13b	0.62
13c	0.15
13d	0.41
13e	0.26

NOTE: Extracted from Table 11-XLIV pg 87, "Consultants' Report".

Figure 1

LOCATION MAP

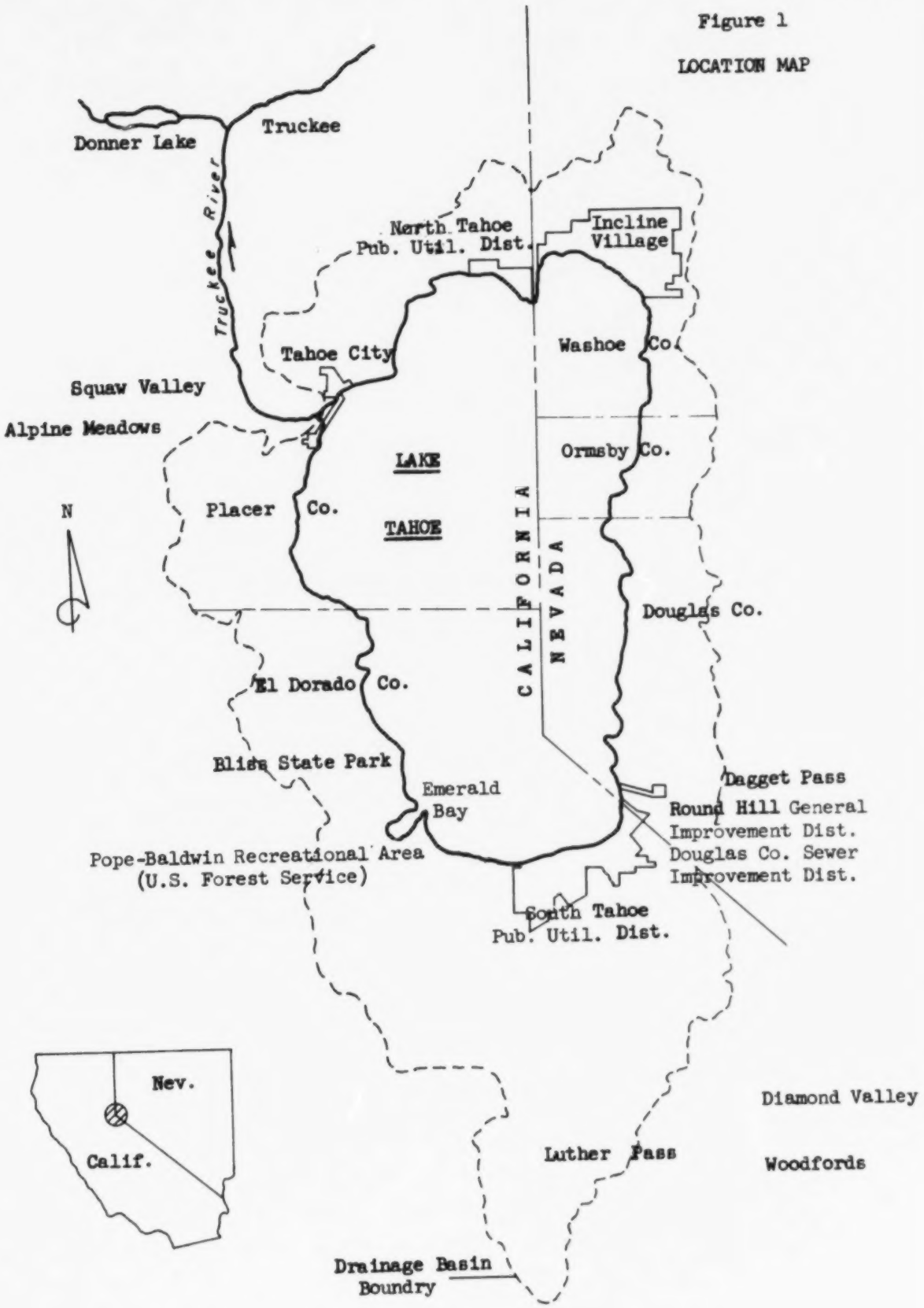

Figure 2
ESTIMATED NITROGEN & PHOSPHORUS
Sewage Loads to Tahoe Basin
(1966 Summertime Peak)

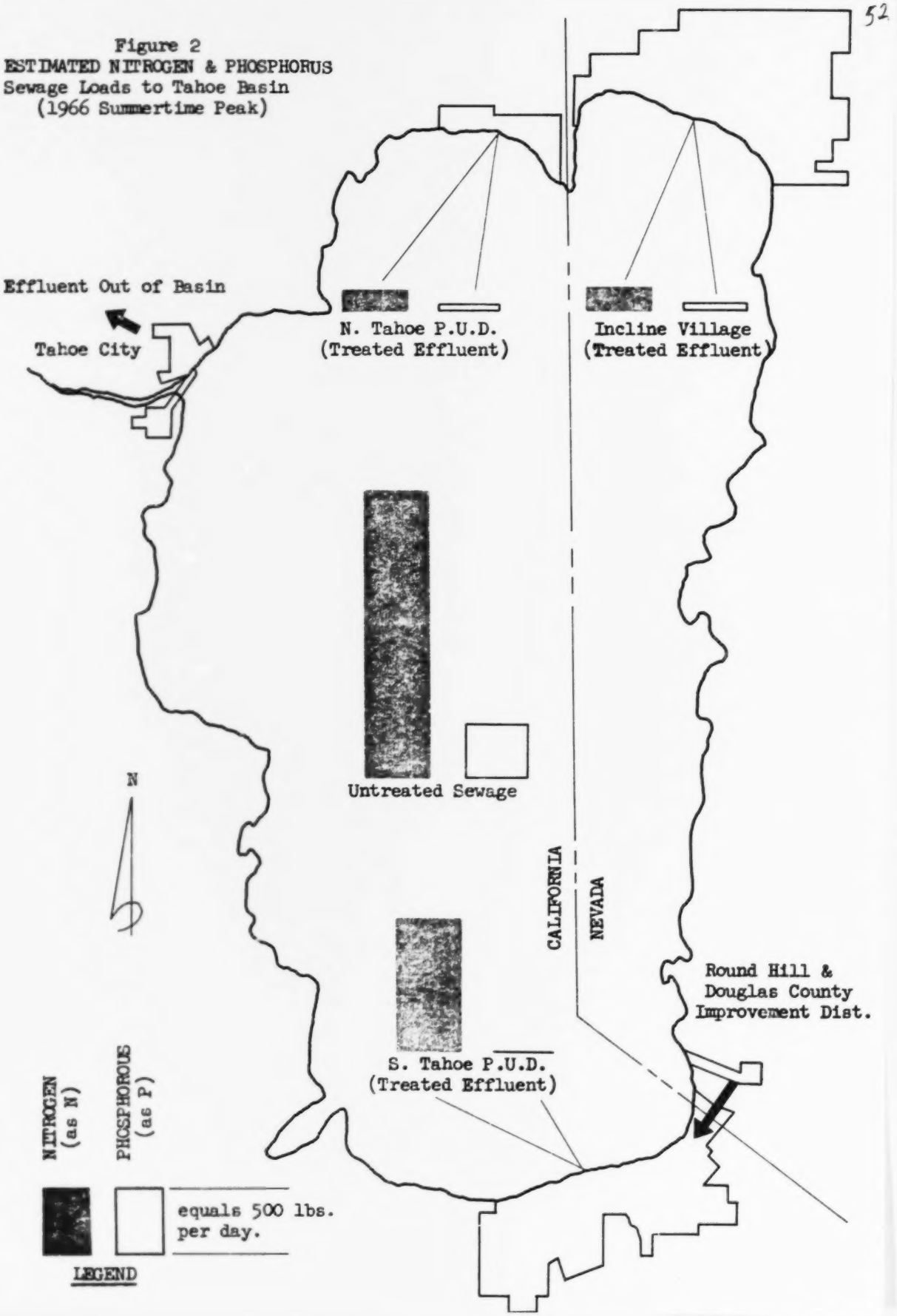

Figure 3

ESTIMATED NITROGEN LOADS

Sources & Net Discharge to Basin

(1966 & 2010 Annual Averages)

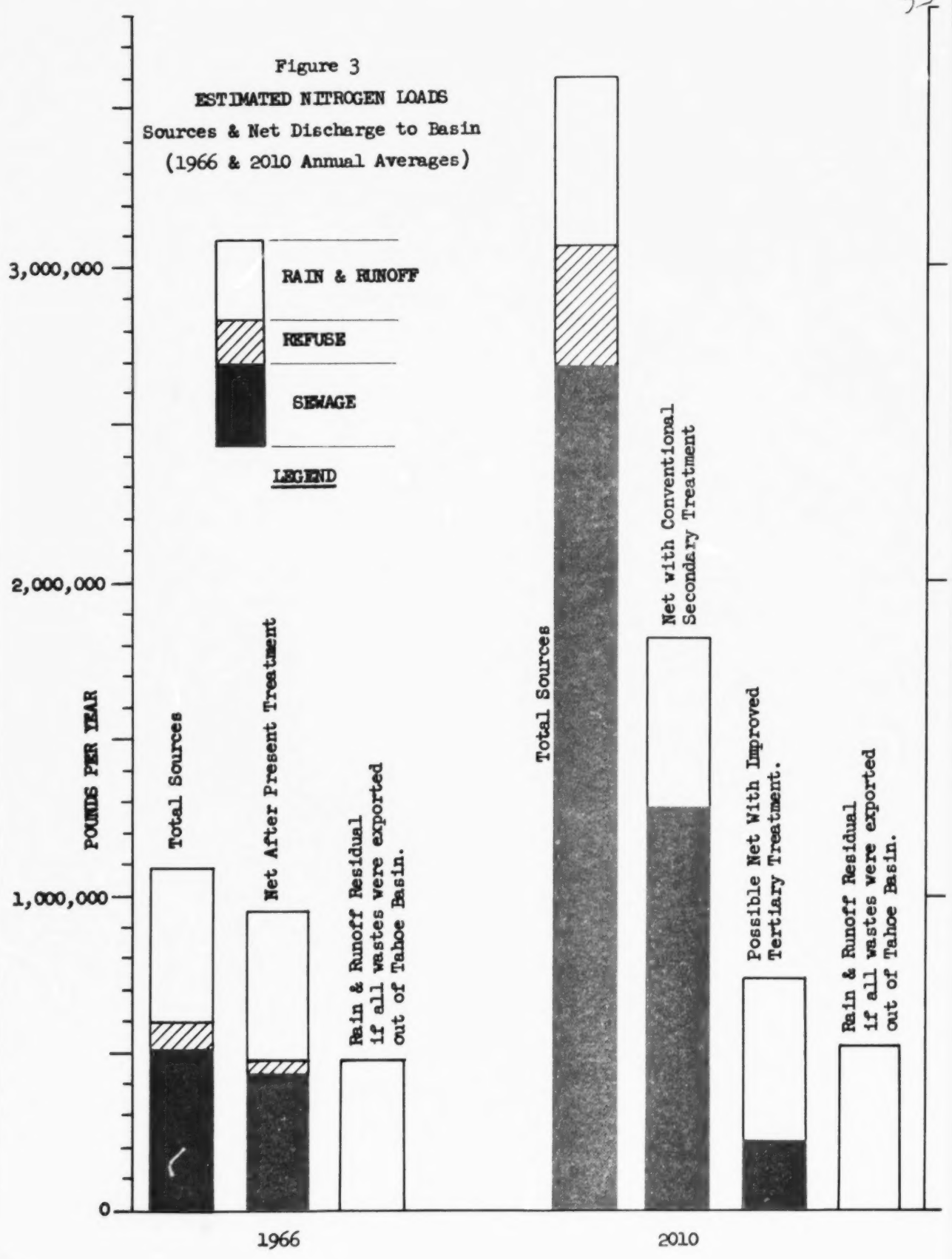

Figure 4

ESTIMATED PHOSPHORUS LOADS

Sources & Net Discharge to Basin
(1966 & 2010 Annual Averages)

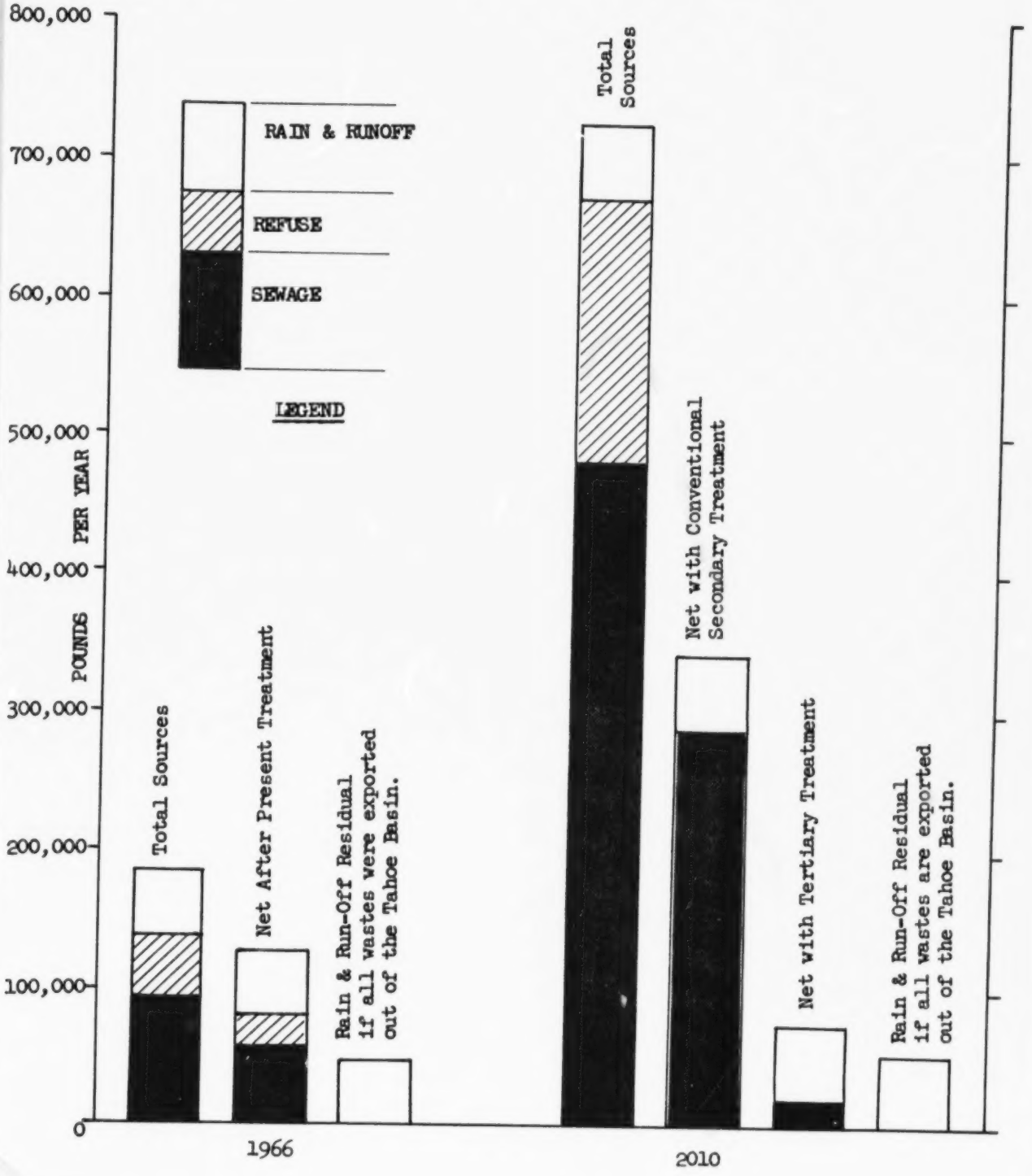

Figure 5

SAMPLING AREAS
IN LAKE TAHOE

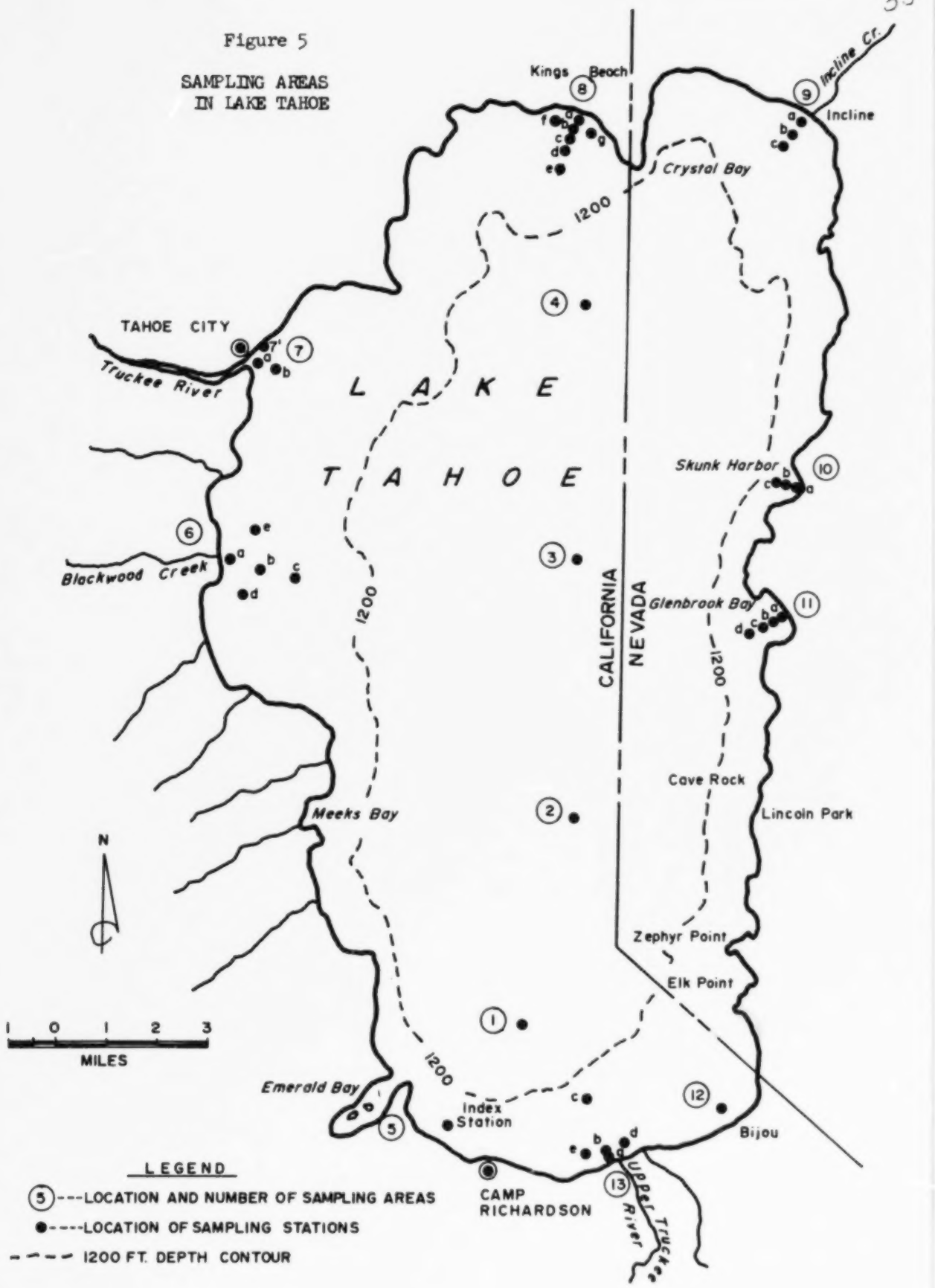

Figure 6

CHLOROPHYLL a